

CHEMICAL LABORATORY UNIT CORRECTION LIST (2000 edition, NFPA 45)

PLEASE NOTE: Circled items require correction by revised plans, addenda, field orders, or change orders before plans can be approved for construction. Answers in letter form **are not** acceptable. Starting construction before plans approval may be considered as just cause, by the State, to issue a **stop work** order. [Rule 0780-2-3-.05] Issues of conflict between the Life Safety Code (NFPA 101 2003 edition) and the building code (SBC 1999 edition) will be resolved by accepting only the most stringent. [Rule 0780-2-2-.04]

I. PROCEDURES

1. Provide two copies of plans and one copy of specifications sealed (with signature and date) by a registrant in accordance with the Architects and Engineers Licensing Law Rules. [Rule 0780-2-3-.03 and A&E Rule 0120-2-.08(3)] Other occupancy correction lists (such as business occupancy) may need to be utilized as well.
2. Provide on the cover sheet the classification type of Laboratory: Class A, Class B, Class C, and Class D.
3. Provide a material safety data sheet for every chemical used in the building.

II. LABORATORY UNIT FIRE HAZARD CLASSIFICATION [NFPA 45 2.2]

1. Laboratory units shall be classified as Class A (High Fire Hazard), Class B (Moderate Fire Hazard), Class C (Low Fire Hazard), or Class D (Minimal Fire Hazard), according to the quantities of flammable and combustible liquids specified in Table 2.2.1(a) and Table 2.2.1(b). [NFPA 45 2.2.1]
2. The total amount of flammable and combustible liquids outside of flammable liquid storage rooms shall not exceed the quantities presented for Class D laboratory units in Table 2.2.1(a) or 2.2.1(b). (See 1.1.1, Exception No. 1.) [NFPA 45 2.2.1.4.1]
3. Quantities of flammable and combustible liquids, including liquids in laboratory units located in health care occupancies, shall not exceed those specified for a Class D laboratory unit. [NFPA 45 2.2.1.4.2]
4. For the purposes of determining laboratory fire hazard classification and the use of Tables 2.2.1(a) and 2.2.1(b), quantities of liquefied flammable gases shall be treated as if they were Class I flammable liquids; that is, 4 L (1.1 gal) of liquefied flammable gas is to be considered equivalent to 4 L (1.1 gal) of Class I flammable liquid. [NFPA 45 2.2.1.5]
5. Experiments and tests conducted in instructional laboratory units shall be under the direct supervision of an instructor.
 - a) Laboratory units used for instructional purposes shall be limited to 50 percent of the flammable and combustible liquids quantity for Class B laboratory units presented in Table's 2.2.1(a) and 2.2.1(b).
 - b) Laboratory units used for the instruction of students through the 12th grade shall be limited to 50 percent of the flammable and combustible liquids quantity for Class C laboratory units presented in Tables 2.2.1(a) and 2.2.1(b). [NFPA 45 2.2.2]

II.a. LABORATORY WORK AREA AND LABORATORY UNIT EXPLOSION HAZARD CLASSIFICATION [NFPA 45 2.3]

1. A laboratory work area shall be considered to contain an explosion hazard if an explosion of quantities or concentrations of materials in 2.3.1(1) through (5) could result in serious or fatal injuries to personnel within that laboratory work area. [NFPA 45 2.3.1]
2. A laboratory unit shall not be considered to contain an explosion hazard unless a laboratory work area within that unit contains an explosion hazard great enough to cause major property damage or serious injury outside that laboratory work area. [NFPA 45 2.3.2]

III. LABORATORY UNIT DESIGN AND CONSTRUCTION [NFPA 45 3.1]

1. The required construction of laboratory units shall be in accordance with Tables 3.1.1(a) and 3.1.1(b). [NFPA 45 3.1.1]
2. Regardless of the construction and fire protection requirements for laboratory units that are specified in Table 3.1.1(a) or Table 3.1.1(b), laboratory units in educational occupancies shall be separated from nonlaboratory areas by 1-hour construction. [NFPA 45 3.1.3]
3. Table 3.1.1(a) shall pertain to laboratory units protected by automatic sprinkler systems in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems. Where water will create a serious fire or personnel hazard, a suitable nonwater automatic extinguishing system shall be permitted to be an acceptable substitute for sprinklers. [NFPA 45 3.1.4]
4. Penetrations through fire-rated floor/ceiling and wall assemblies by pipes, conduits, bus ducts, cables, wires, air ducts, pneumatic tubes and ducts, and similar building service equipment shall be protected in accordance with NFPA 101. [NFPA 45 3.1.5]
5. All floor openings shall be sealed or curbed to prevent liquid leakage to lower floors. [NFPA 45 3.1.6]
6. Door assemblies in 1-hour-rated fire barriers shall be $\frac{3}{4}$ -hour rated. Door assemblies in 2-hour-rated fire barriers shall be $1\frac{1}{2}$ -hour rated. [NFPA 45 3.1.7]
7. Window assemblies shall be permitted in fire-rated wall assemblies having a required fire resistance rating of 1 hour or less. Window assemblies shall be of an approved type and shall have a fire protection rating in accordance with NFPA 101, Life Safety Code. Fire window assemblies shall be installed in accordance with NFPA 80, Standard for Fire Doors and Fire Windows. [NFPA 45 3.1.8]
8. Openings in fire-rated floor/ceiling and wall assemblies for air-handling ductwork or air movement shall be protected in accordance with NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems. [NFPA 45 3.1.9]
9. The maximum area of a laboratory unit shall be determined by the fire hazard classification [NFPA 45 3.2]
10. Life safety requirements for noninstructional laboratory units shall be in accordance with Chapter 28, Industrial Occupancies, in NFPA 101, Life Safety Code. [NFPA 45 3.3.1]
11. Life safety requirements for instructional laboratory units for grades 12 and below shall be in accordance with NFPA 101, Life Safety Code, for an educational occupancy. [NFPA 45 3.3.2]

12. Life safety requirements for instructional laboratory units for above grade 12, and for Class D medical laboratories located in facilities classified as business occupancies, shall be in accordance with the NFPA 101 [NFPA 45 3.3.3]

III.a. DUCT CONSTRUCTION FOR HOODS AND LOCAL EXHAUST SYSTEMS [NFPA 45 6.5]

1. Ducts from laboratory hoods and from local exhaust systems shall be constructed entirely of noncombustible materials. [NFPA 45 6.5.1]
2. Combustible ducts or duct linings shall have a flame spread index of 25 or less when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. Test specimens shall be of the minimum thickness used in the construction of the duct or duct lining. [NFPA 45 6.5.2]
3. Linings and coatings containing such fill as fiberglass, mineral wool, foam, or other similar material that could accumulate chemical deposits shall not be permitted within laboratory exhaust systems. [NFPA 45 6.5.3]
4. Duct systems for perchloric acid hoods shall be constructed in accordance with Section 6.11. [NFPA 45 6.5.4]
5. Materials used for vibration isolation connectors shall comply with 6.5.2. [NFPA 45 6.5.6]
6. Flexible connectors containing pockets in which conveyed material can collect shall not be used in any concealed space or where strong oxidizing chemicals are used (e.g., perchloric acid). [NFPA 45 6.5.7]
7. Controls and dampers, where required for balancing or control of the exhaust system, shall be of a type that, in event of failure, will fail open to ensure continuous draft. [NFPA 45 6.5.8 and 6.10.3]
8. Hand holes, where installed for damper, sprinkler, or fusible link inspection or resetting and for residue clean-out purposes, shall be equipped with tight-fitting covers provided with substantial fasteners. [NFPA 45 6.5.9]

III.b. EXPLOSION-RESISTANT CONSTRUCTION [NFPA 45 5.2]

1. When explosion-resistant construction is used, adequately designed explosion resistance shall be achieved by the use of one of the following methods:
 - a) Reinforced concrete walls
 - b) Reinforced and fully grouted concrete block walls
 - c) Steel walls
 - d) Steel plate walls with energy-absorbing linings
 - e) Barricades, such as those used for explosives operations, constructed of reinforced concrete, sand-filled/wood-sandwich walls, wood-lined steel plate, or earthen or rock berms
 - f) Specifically engineered construction assemblies [NFPA 45 5.2]

III.c. MEASURING DEVICE FOR HOOD AIRFLOW [NFPA 45 6.8.7]

1. A measuring device for hood airflow shall be provided on each laboratory hood. And shall be a permanently installed device and shall provide constant indication to the hood user of adequate or inadequate hood airflow. [NFPA 45 6.8.7.1 and 6.8.7.2]

IV. MEANS OF ACCESS TO AN EXIT [NFPA 45 3.4]

1. A second means of access to an exit shall be provided from a laboratory work area if any of the situations described in 3.4.1(1) through (6) exist.
 - a) A laboratory work area contains an explosion hazard located so that an incident would block escape from or access to the laboratory work area.
 - b) A laboratory work area within a Class A laboratory unit exceeds 500 ft².
 - c) A laboratory work area within a Class B, Class C, or Class D laboratory unit exceeds 1000 ft².
 - d) A hood in a laboratory work area is located adjacent to the primary means of exit access.
 - e) A compressed gas cylinder is in use and the following exist when the cylinder
 1. Is larger than lecture bottle size [approximately (2 in. 13in.).
 2. Contains a gas that is flammable or has a Health Hazard Rating of 3 or 4.
 3. Could prevent safe egress in the event of accidental release of cylinder contents.
 - f) A cryogenic container is in use that
 1. Contains a flammable gas or has a Health Hazard Rating of 3 or 4.
 2. Could prevent safe egress in the event of accidental release of container contents.

[NFPA 45 3.4.2]
2. Emergency lighting facilities shall be provided for any laboratory work area requiring a second means of access to an exit, in accordance with 3.4.1. [NFPA 45 3.4.2]
3. The required exit access doors of all laboratory work areas within Class A or Class B laboratory units shall swing in the direction of exit travel. [NFPA 45 3.4.3]
4. The required exit access doors of all laboratory work areas within Class C or Class D laboratory units shall be permitted to swing against the direction of exit travel or shall be permitted to be a horizontal sliding door complying with NFPA 101. [NFPA 45 3.4.4]
5. Emergency lighting in laboratory work areas and exits shall be installed in accordance with Section 7.9, Emergency Lighting, of NFPA 101[NFPA 45 3.4.5]
6. Furniture, casework, and equipment in laboratory units shall be arranged so that means of access to an exit can be reached easily from any point. [NFPA 45 3.5]
7. Entrances to laboratory units, laboratory work areas, storage areas, and associated facilities shall be identified by signs to warn emergency response personnel of unusual or severe hazards that are not directly related to the fire hazard of contents. The hazards shall be communicated in the plans for fire fighting. [NFPA 45 4.6.3.1 and 10.1]

IV.a. UNAUTHORIZED ACCESS [NFPA 45 5.4]

1. Properly posted doors, gates, fences, or other barriers shall be provided to prevent unauthorized access to the following:
 - a) Laboratory work areas containing an explosion hazard
 - b) Laboratory units containing an explosion hazard
 - c) The space between explosion vents and fragment barriers [NFPA 45 5.4]

V. LABORATORY HOOD INTERIORS [NFPA 45 6.8.0]

1. Materials of construction used for the interiors of new laboratory hoods or for the modification of the interiors of existing laboratory hoods shall have a flame spread index of 25 or less when tested according to NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. [NFPA 45 6.8.1.1]
2. The sash, if provided, shall be glazed with material that will provide protection to the operator against the hazards associated with the use of the hood. (See also Appendix C.) [NFPA 45 6.8.2]
3. Laboratory hood sashes shall be kept closed whenever possible. When a fume hood is unattended, its sash shall remain fully closed. [NFPA 45 6.8.3]
4. In installations where services and controls are within the hood, additional electrical disconnects shall be located within 15 m (50 ft) of the hood and shall be accessible and clearly marked. [NFPA 45 6.8.4]
5. For new installations or modifications of existing installations, controls for laboratory hood services (gas, air, water, etc.) shall be located external to the hood and within easy reach. [NFPA 45 6.8.5.1]
6. In existing installations where service controls are within the hood, additional shutoffs shall be located within 15 m (50 ft) of the hood and shall be accessible and clearly marked. [NFPA 45 6.8.5.2]

VI. LABORATORY VENTILATING SYSTEMS AND HOOD REQUIREMENTS [NFPA 45 6.0]

1. Laboratory hoods shall not be relied upon to provide explosion (blast) protection unless specifically designed to do so. (See also C.5.4 and C.5.5 for further information on explosion-resistant hoods and shields.) [NFPA 45 6.2.2]
2. Laboratory hoods using perchloric acid shall be in accordance with Section 6.11. [NFPA 45 6.2.3]

VI.a. SUPPLY SYSTEMS [NFPA 45 6.3]

1. Laboratory ventilation systems shall be designed to ensure that chemicals originating from the laboratory shall not be recirculated. The release of chemicals into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition. [NFPA 45 6.3.1]
2. The location and configuration of fresh air intakes shall be chosen so as to avoid drawing in chemicals or products of combustion coming either from the laboratory building itself or from other structures and devices. [NFPA 45 6.3.2]
3. Laboratory units in which chemicals are present shall be continuously ventilated. [NFPA 45 6.3.3]
4. The air pressure in the laboratory work areas shall be negative with respect to corridors and nonlaboratory areas. [NFPA 45 6.3.4]
5. The location of air supply diffusion devices shall be chosen so as to avoid air currents that would adversely affect the performance of laboratory hoods, exhaust systems, and fire detection or extinguishing systems. (See Sections 4.2 and 4.5, and 6.9.1.) [NFPA 45 6.3.5]

VI.b. EXHAUST AIR DISCHARGE [NFPA 45 6.4]

1. Air exhausted from laboratory hoods and other special local exhaust systems shall not be recirculated. (See also 6.3.1.) [NFPA 45 6.4.1]
2. If energy conservation devices are used, they shall be designed in accordance with 6.3.1. Devices that could result in recirculation of exhaust air or exhausted contaminants shall not be used unless designed in accordance with Section 4:10.1, "Nonlaboratory Air," and Section 4:10.2, "General Room Exhaust," of ANSI/AIHA Z9.5, Laboratory Ventilation. [NFPA 45 6.4.2]
3. Air exhausted from laboratory work areas shall not pass unducted through other areas. [NFPA 45 6.4.3]
4. Air from laboratory units and laboratory work areas in which chemicals are present shall be continuously discharged through duct systems maintained at a negative pressure relative to the pressure of normally occupied areas of the building. [NFPA 45 6.4.4]
5. Positive pressure portions of the lab hood exhaust systems (e.g., fans, coils, flexible connections, and ductwork) located within the laboratory building shall be sealed airtight or located in a continuously mechanically ventilated room. [NFPA 45 6.4.5]
6. Laboratory hood face velocities and exhaust volumes shall be sufficient to contain contaminants generated within the hood and exhaust them outside of the laboratory building. The hood shall provide containment of the possible hazards and protection for personnel at all times when chemicals are present in the hood. [NFPA 45 6.4.6]
7. Special local exhaust systems, such as snorkels or "elephant trunks," shall have sufficient capture velocities to entrain the chemical being released. [NFPA 45 6.4.7]
8. Canopy hoods shall not be used in lieu of laboratory hoods. [NFPA 45 6.4.8]
9. Biological safety cabinets and laminar flow cabinets shall not be used in lieu of laboratory hoods. [NFPA 45 6.4.9 and 6.4.10]
10. Air exhausted from laboratory hoods and special exhaust systems shall be discharged above the roof at a location, height, and velocity sufficient to prevent re-entry of chemicals and to prevent exposures to personnel. [NFPA 45 6.4.11]

VI.c. MANIFOLDING OF LABORATORY HOOD AND DUCTS [NFPA 45 6.5.10]

1. Exhaust ducts from each laboratory unit shall be separately ducted to a point outside the building, to a mechanical room, or to a shaft. (See 3.1.5 and 6.10.3.) [NFPA 45 6.5.10.1]
2. Connection to a common laboratory hood exhaust duct system shall be permitted to occur within a building only in any of the following locations:
 - a) Mechanical room protected in accordance with Tables 3.1.1(a) and 3.1.1(b)
 - b) Shaft protected in accordance with the chapter for protection of vertical openings of NFPA 101, Life Safety Code
 - c) A point outside of the building [NFPA 45 6.5.10.2]
3. Exhaust ducts from laboratory hoods and other exhaust systems within the same laboratory unit shall be permitted to be combined within that laboratory unit. (See 6.4.1.) [NFPA 45 6.5.10.3]

4. Duct velocities of laboratory exhaust systems shall be high enough to minimize the deposition of liquids or condensable solids in the exhaust systems during normal operations in the laboratory hood. [NFPA 45 6.6]
5. Fans conveying both corrosive and flammable or combustible materials shall be permitted to be lined with or constructed of corrosion-resistant materials having a flame spread index of 25 or less when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials. [NFPA 45 6.7.2]
6. Fans shall be located and arranged so as to afford ready access for repairs, cleaning, inspection, and maintenance. [NFPA 45 6.7.3]
7. Where flammable gases or vapors or combustible dusts are passed through the fans, the rotating element shall be of nonferrous or spark-resistant construction. Alternatively, the casing shall be constructed of or lined with such material. Where there is the possibility of solid material passing through the fan that would produce a spark,.. [NFPA 45 6.7.4]
8. Motors and their controls shall be located outside the location where flammable or combustible vapors or combustible dusts are generated or conveyed, unless specifically approved for that location and use. [NFPA 45 6.7.5]
9. Exhaust systems used for the removal of hazardous materials shall be identified to warn personnel of the possible hazards. [NFPA 45 10.2]

VI.d. HEATING OPERATIONS [NFPA 45 9.1.2.0]

1. All heating of flammable or combustible liquids shall be conducted so as to minimize fire hazards. [NFPA 45 9.1.2.1]
2. Provisions shall be made to contain liquid that might be accidentally released from glass apparatus containing more than 0.25 L (8.4 oz) of flammable liquid or combustible liquid heated to its flash point. Supplementary fire extinguishing equipment shall be provided, if necessary. [NFPA 45 9.1.2.2]
3. Unattended operations shall be provided with override control and automatic shutdown to prevent system failure that can result in fire or explosion. [NFPA 45 9.1.2.3]
4. Strong oxidizing materials, such as perchloric acid, shall not be heated by gas flames or oil baths. [NFPA 45 9.1.2.4]

VI.e. EXPLOSION VENTING [NFPA 45 5.3]

1. When explosion venting is used, it shall be designed so that
 - a) Fragments will not strike other occupied buildings or emergency response staging areas
 - b) Fragments will not strike critical equipment (e.g., production, storage, utility services, and fire protection)
 - c) * Fragments will be intercepted by blast mats, energy-absorbing barrier walls, or earthen Berms [NFPA 45 5.3]

VII. LABORATORY HOOD FIRE PROTECTION [NFPA 45 6.10]

1. Automatic fire protection systems shall not be required in laboratory hoods or exhaust systems. (See Exception No. 1 and No. 2) [NFPA 45 6.10.1]

2. Automatic fire protection systems, where provided, shall comply with the following standards, as applicable:
 - a) NFPA 12, Standard on Carbon Dioxide Extinguishing Systems
 - b) NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems
 - c) NFPA 13, Standard for the Installation of Sprinkler Systems
 - d) NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection
 - e) NFPA 17, Standard for Dry Chemical Extinguishing Systems
 - f) NFPA 17A, Standard for Wet Chemical Extinguishing Systems
 - g) * NFPA 750, Standard on Water Mist Fire Protection Systems
3. Automatic fire dampers shall not be used in laboratory hood exhaust systems. Fire detection and alarm systems shall not be interlocked to automatically shut down laboratory hood exhaust fans. (See Exception No. 1 and No. 2) [NFPA 45 6.10.3]
4. For Perchloric Acid Hoods see Chapter 6.11 for requirements.

VIII. HANDLING AND STORAGE [NFPA 45 7.2]

1. Chemicals shall not be brought into a laboratory work area unless design, construction, and fire protection of receiving and storage facilities are commensurate with the quantities and hazards of chemicals involved. [NFPA 45 7.2.1.1]
2. Receiving, transporting, unpacking, and dispensing of chemicals and other hazardous materials shall be carried out by trained personnel in such locations and in such a manner as to minimize hazards from flammable, reactive, or toxic materials. [NFPA 45 7.2.2.1]

IX. EXPLOSION HAZARD PROTECTION [NFPA 45 5.0]

1. When a laboratory work area or a laboratory unit is considered to contain an explosion hazard, as defined in 2.3.1 and 2.3.2, appropriate protection shall be provided for the occupants of the laboratory work area, the laboratory unit, adjoining laboratory units, and nonlaboratory areas. (See Appendix C for further information.) [NFPA 45 5.1.1]
2. Protection shall be provided by one or more of the following:
 - a) Limiting amounts of flammable or reactive chemicals or chemicals with unknown characteristics used in or exposed by experiments
 - b) Special preventive or protective measures for the reactions, equipment, or materials themselves (e.g., high-speed fire detection with deluge sprinklers, explosion-resistant equipment or enclosures, explosion suppression, and explosion venting directed to a safe location) (see 4.2.3)
 - c) Explosion-resistant walls or barricades around the laboratory work area containing the explosion hazard (see Section 5.2)
 - d) Remote control of equipment to minimize personnel exposure
 - e) Sufficient deflagration venting in outside walls to maintain the integrity of the walls separating the hazardous laboratory work area or laboratory unit from adjoining areas
 - f) Conducting experiments in a detached or isolated building, or outdoors [NFPA 45 5.1.2]
3. For compressed and liquefied gases see chapter 8.

X. ELECTRICAL INSTALLATION [NFPA 45 3.6]

1. All electrical installations, including wiring and appurtenances, apparatus, lighting, signal systems, alarm systems, remote control systems, or parts thereof, shall comply with NFPA 70, National Electrical Code. [NFPA 45 3.6]

2. Electrical receptacles, switches, and controls shall be located so as not to be subject to liquid spills. [NFPA 45 3.6.1]
3. Laboratory work areas, laboratory units, and laboratory hood interiors shall be considered as unclassified electrically with respect to Article 500 of NFPA 70, National Electrical Code. [NFPA 45 3.6.2]

X.a. FIRE PROTECTION [NFPA 45 4.0]

1. All laboratory units shall be provided with fire protection appropriate to the fire hazard, as follows:
 - a) Portable fire extinguishers (see Section 4.4)
 - b) Fire alarm systems (see Section 4.5)
 - c) Evacuation and emergency plans (see Section 4.6) [NFPA 45 4.1.1]
2. In addition to the fire protection specified in 4.1.1, laboratory units under some conditions shall be provided with automatic extinguishing systems (see Section 4.2) and inside standpipe and hose systems (see Section 4.3). [NFPA 45 4.1.2]
3. An automatic sprinkler system complying with NFPA 13, Standard for the Installation of Sprinkler Systems, shall be provided for the protection of any belowgrade laboratory work area. [NFPA 45 4.1.3]

X.b. AUTOMATIC FIRE EXTINGUISHING SYSTEMS [NFPA 45 4.2]

1. An automatic sprinkler system, where required by Table 3.1.1(a), depending on the construction of the building, the hazard class of the laboratory unit, the construction of the laboratory unit enclosure, and the area of the laboratory unit shall be in accordance with the following:
 - a) Automatic sprinkler system protection for Class A and Class B laboratories shall be in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, for Ordinary Hazard (Group 2) occupancies.
 - b) Automatic sprinkler system protection for Class C and Class D laboratories shall be in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, for Ordinary Hazard (Group 1) occupancies. [NFPA 45 4.2.1.1]
2. Automatic sprinkler systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems. [NFPA 45 4.2.1.2]

X.c. OTHER AUTOMATIC EXTINGUISHING SYSTEMS [NFPA 45 4.2.2]

1. Where required or used in place of automatic sprinkler systems, special hazard extinguishing systems and nonwater automatic extinguishing systems shall be designed, installed, and maintained in accordance with the following standards, as applicable:
 - a) NFPA 11, Standard for Low-Expansion Foam
 - b) NFPA 11A, Standard for Medium- and High-Expansion Foam Systems
 - c) NFPA 12, Standard on Carbon Dioxide Extinguishing Systems
 - d) NFPA 12A, Standard on Halon 1301 Fire Extinguishing Systems
 - e) NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection
 - f) NFPA 17, Standard for Dry Chemical Extinguishing Systems
 - g) NFPA 17A, Standard for Wet Chemical Extinguishing Systems
 - h) NFPA 69, Standard on Explosion Prevention Systems
 - i) NFPA 750, Standard on Water Mist Fire Protection Systems. [NFPA 45 4.2.2]

2. The discharge of an automatic fire extinguishing system shall activate an audible fire alarm system on the premises. [NFPA 45 4.2.3]
3. In all laboratory buildings that are two or more stories above or below the grade level (level of exit discharge), standpipes shall be installed in accordance with NFPA 14, Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems. [NFPA 45 4.3.1]
4. Standpipe systems shall be regularly inspected, tested, and maintained in accordance with NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems. [NFPA 45 4.3.2]
5. Hose lines shall be of an approved type and shall be tested and maintained in accordance with NFPA 1962, Standard for the Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles. [NFPA 45 4.3.3]

X.d. PORTABLE FIRE EXTINGUISHERS [NFPA 45 4.4]

1. Portable fire extinguishers shall be installed, located, and maintained in accordance with NFPA 10, Standard for Portable Fire Extinguishers. [NFPA 45 4.4.1]
2. For purposes of sizing and placement of fire extinguishers for Class B fires (Table 3-3.1 of NFPA 10, Standard for Portable Fire Extinguishers), Class A laboratory units shall be rated as extra (high) hazard, and Class B, Class C, and Class D laboratory units shall be rated as ordinary (moderate) hazard. [NFPA 45 4.4.2]

X.e. FIRE ALARM SYSTEMS [NFPA 45 4.5]

1. Fire alarm systems, where provided, shall be installed and maintained in accordance with NFPA 72, National Fire Alarm Code. [NFPA 45 4.5.1]
2. Class A and Class B laboratory units shall have a manual fire alarm system installed and maintained in accordance with NFPA 72, National Fire Alarm Code. [NFPA 45 4.5.2]
3. The fire alarm system, where provided, shall be designed so that all personnel endangered by the fire condition or a contingent condition shall be alerted. [NFPA 45 4.5.3]
4. The fire alarm system shall alert local emergency responders or the public fire department. [NFPA 45 4.5.4]

X.f. FIRE PREVENTION PROCEDURES [NFPA 45 4.6]

1. Fire prevention procedures shall be established. Certain critical areas shall require special consideration, including, but not limited to, the following:
 - a) Handling and storage of chemicals, flammable and combustible liquids, and gases
 - b) Open flame and spark-producing equipment work permit system
 - c) Arrangements and use of portable electric cords
 - d) Smoking area controls. [NFPA 45 4.6.1]
2. All unattended electrical heating equipment shall be equipped with a manual reset over-temperature shutoff switch, in addition to normal temperature controls, if overheating could result in a fire or explosion. [NFPA 45 9.2.3.1]
3. Heating equipment with circulation fans shall be equipped with an interlock arranged to disconnect current to the heating elements if the fan fails. [NFPA 45 9.2.3.2]

4. Burners, induction heaters, ovens, furnaces, and other heat-producing equipment shall be located a safe distance from areas where temperature-sensitive and flammable materials and compressed gases are handled. [NFPA 45 9.2.3.3]
5. Oven and furnace installations shall comply with NFPA 86, Standard for Ovens and Furnaces. [NFPA 45 9.2.3.4]
6. Electric motors shall be suitable for Class I, Division 2 locations when flammable and combustible liquids or flammable gas concentrations can produce hazardous concentrations of flammable mixtures. [NFPA 45 9.2.5]

X.g. EMERGENCY PLANS [NFPA 45 4.6.3]

1. Plans for laboratory emergencies shall be developed. Such plans shall include the following:
 - a) Alarm activation
 - b) Evacuation and building re-entry procedures
 - c) Equipment shutdown procedures or applicable emergency operation
 - d) Fire-fighting operations
 - e) * Nonfire hazards [NFPA 45 4.6.3.1]